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DEEP SEA CABLES.

THE question of cheaper and yet more durable cables than our present types must constantly form a subject for discussion and invention. The present type of Atlantic cables has answered undoubtedly the requirements of Atlantic telegraphy: for as long as monopoly existed the price of the cable was not of great importance; and as regards durability, they have also been tolerably successful, in spite of one having been out of order for three years. But other localities show that a cheaper cable is required, for the ordinary shares of our long-line companies remain steadily at a discount.

Light cables—cables without any outer sheathing—are suggested as the remedy, and against the present types, besides their expense, it is argued that the steel or iron, corroding at places where they hang over uneven ground, expose the cable to the chances of gradually dropping to pieces, and undoubtedly some of the old iron-covered cables, which had no protection from rust, and which were laid very tight, suffered greatly from this cause. The cable in places gets heavier, by the coral and marine vegetation that clings to it, whilst getting weaker. The protection afforded by yarn and asphalte has, no doubt, lessened this danger; but the yarn at some places in a few years becomes rotten, and the least disturbance removes it. Suppress the iron wires altogether, say the light cable advocates; but then what are we to place instead of it?

An ordinary guttapercha-covered copper wire will scarcely support two miles of its own length in water. If the ship has to be stopped for a fault of insulation, or even for a false alarm, the line would therefore simply break. Something more is required, therefore, even to lay the wire. Some suggest hemp outside, and others steel between the copper and the insulating material—Allan's patent. There are difficulties with both. The hemp, if laid up loosely, will not support the guttapercha, and, if laid tight, is liable to distort itself into kinks. We do not say the difficulty may not be overcome. With the Allan cable, the electrical conductivity would be greatly reduced with a given diameter of compound conductor, and, consequently, the speed of signalling. The joints are also a difficulty. No doubt the Allan cable would have the advantage when down of having such strength as the steel wires give it well protected from decay. On the other hand, both cables would be quite unprotected from marine insects, and, should a fault occur after they were down, their small absolute tensile strength would render them difficult to feel when dredging. Such cables would also run the chances of marine accumulations on them to weight them, if hanging in festoons over rough ground, just as much as the iron or steel covered cables.

Of the patterns that have been at various times proposed, we have the Allan cable—viz., copper, surrounded by fine steel wires—and this compound conductor insulated with guttapercha. Next, Mr. Siemens' cable of ordinary conductor and insulaters, with hemp strands and copper sheathing, and the same with iron or steel wires, hemp and copper sheathing. Mr. Varley proposed a light cable where the insulated wire was laid up with two hemp cords. The cable introduced a few years ago by Mr. Bullevant, of two servings of hemp strands round an insulated wire, with a whipping round the whole, was an improvement on that which Mr. Rowett some years pushed forward, and which consisted of an insulated wire, placed as the heart of an ordinary manilla rope. But Mr. Newall had, previous to this, laid a portion of a line between Candia and Alexandria of almost the same pattern, except that the proportion of hemp to the core was much more scanty than in the samples of Rowett's that were handed about at the time that Mr. Rowett was endeavouring to introduce his cable. The Candia cable was lost. But even this was not the first hemp-covered cable attempted to be laid, for in about the year 1852 or '53, a hemp-covered cable was attempted between Donaghadee and Portpatrick, but it never got further than a few fathoms from the shore, and we once heard one of those engaged on this work describe the attachment of pieces of stone by spun yarn stops to it to moor it.

Another kind of cable of a smaller and lighter pattern than the usual form is described by Mr. Newall in the evidence before the joint committee on telegraph cables in 1861. It consisted of Hooper's core surrounded by very fine steel wires embedded in a single covering of vulcanized India-rubber. Such a cable would, if it can be manufactured, present many advantages. The steel wires would give it strength and be protected very perfectly from the action of the water quite as well as in the Allan cable, whilst the conductor would remain of copper uncompounded with steel. As regards the cost, we do not suppose that it would, weight for weight of material, be exactly a very cheap cable, but it would certainly be very durable.

The cable lately laid between Australia and New Zealand is the latest attempt to make a cheap cable. It consists of the ordinary core and serving, covered with a sheathing composed alternately of strands of hemp and of steel wires, and the whole served with hemp and asphalte. We can see no particular advantage in this form. The hemp it is very improbable can take its strain with the steel, whilst the principle of the arch as regards the wires touching one another and thus preventing stretch, is even more ignored than in the Atlantic pattern of served wires. In a few years, when the hemp gets soft and rotten, the wires will form a wretched "bird-cage" round the core, and will be easily displaced by any irregular strains that may come on the cable in dredging or hauling in into a hopeless jumble of wire and core.

That improvements will be made in submarine

cables we have no doubt. We do not say that the objections we have mentioned to some of the proposed forms cannot be overcome by experiment and thought, but hitherto there has been no actual pattern that we have seen that could with confidence be recommended, and certainly the New Zealand pattern is one which we feel confident will not survive as the "fittest," however it may be fostered by those in authority as suiting the question of cutting your coat according to your cloth.

Still, in spite of our apparently discouraging remarks, there is no doubt that a new form of cable, combining greater durability of mechanical strength, greater protection from marine insects, and if possible less cost, is a problem which may well occupy the attention of engineers. The difficulty of invention in these cases is, perhaps, much the same as in many other engineering matters. Nobody but contracting firms have the premises and appliances for making samples on a scale fit for experiment, and with them rests the responsibility of any improvement; but we cannot say that the New Zealand type is a promising sample of advancement from contracting firms.

BLOCK SIGNALLING.

(Continued from page 69.)

Fig. 18 represents a complete set of Preece's single wire system. It consists of the usual portions—a semaphore as the block signal, switch, bell, and bell-key (the three latter being similar in construction to those already described as employed in Mr. Preece's three-wire system. The bell and semaphore are combined so as to form one instrument. The semaphore arm is worked from an induced magnet, free to move between the two poles of an electro-magnet, which is placed in the line circuit. The switch acts as a commutator for reversing the battery current, which it carries up to the lower stud of the bell-key. The bell-key is that by which the instruments are operated. To place the distant semaphore signal at danger, it is necessary to first place the switch at ON, and then press the bell-key. The pressure of the bell-key also causes the bell at the distant station to ring a number of times corresponding to the number of times the bell-key is depressed. The bell is worked from a local circuit, which is completed by means of the armature of the semaphore coils.

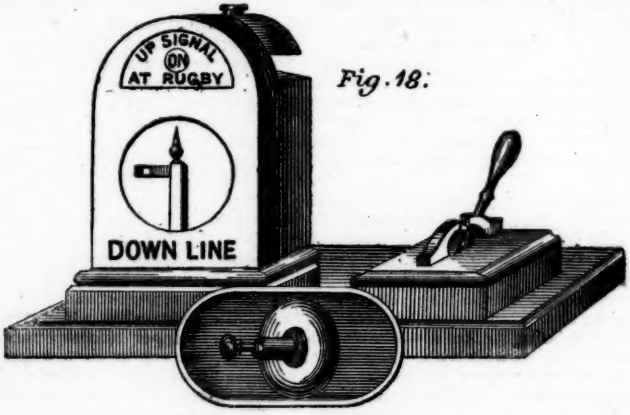


Fig. 18.

Fig. 19 is a symbolical sketch, showing the manner in which the several portions of the apparatus are connected together.

The line enters by the lever *a*, or spring of the signal-key 1, thence it passes to the upper stud *b*, and on to terminal 1 of the semaphore instrument, and thence through the semaphore coils S to earth. Facing the semaphore coils is an armature *d*, which, when at rest, presses against the stud P, which is in electrical circuit with the plate of the instrument.

The batteries are made up in two sets; one, the zinc, is connected to the OFF arc of the switch, the other, the copper, is joined to the ON arc, and the lever which plays between these arcs is in connection with the plate P of the semaphore instrument by way of terminal number 4 of that instrument, which is also connected to the armature *d*.

The bell coils B, which form a portion of the semaphore instrument, are in circuit between the contact point *e*, opposite the armature *d*, and the plate P.

A third, and smaller set of coils R, is also arranged within the semaphore. They form circuit with the plate P and the terminal 3. These are termed the *releasing coils*. Their object will be seen from fig. 20. R R are the coils; *f*, an armature centred at *g*, carrying at its upper end a rod, which, of course, moves with every movement of the armature; *l* is a disc, slotted as shown, having fixed to it, and working upon the same centre, the block signal arm *k*, shown in position by the dotted outline; *m* is a compensating weight; *h* a pin firmly fixed in the edge of the disc; *i* is a wire rod actuated by an induced needle playing between the poles of the electro-magnet S, the one movement of which is that shown in the figure by the continuous line *i*, and the other that shown by the dotted line.

Now if we follow out an incoming *block* and *clear* signal, we shall gain some idea of the combined action of the several portions. Entering at *a*, the current passes to *b*, thence to the semaphore terminal 1 through the coils S to earth. In doing so,

it causes the armature *d* to be attracted towards the contact stud *e*, and so completes the bell circuit, whilst it unlocks the induced needle and leaves it free to move between the poles of S. Should the incoming current be a positive or copper current it will raise the arm actuated by this induced needle shown in the figure. Take now an incoming *clear* signal, the course of which will be the same as that for the opposite signal just traced, with this exception, that being a negative, or zinc current, the rod *i* will be carried over the dotted position (fig. 20); that is, the rod itself will move freely through

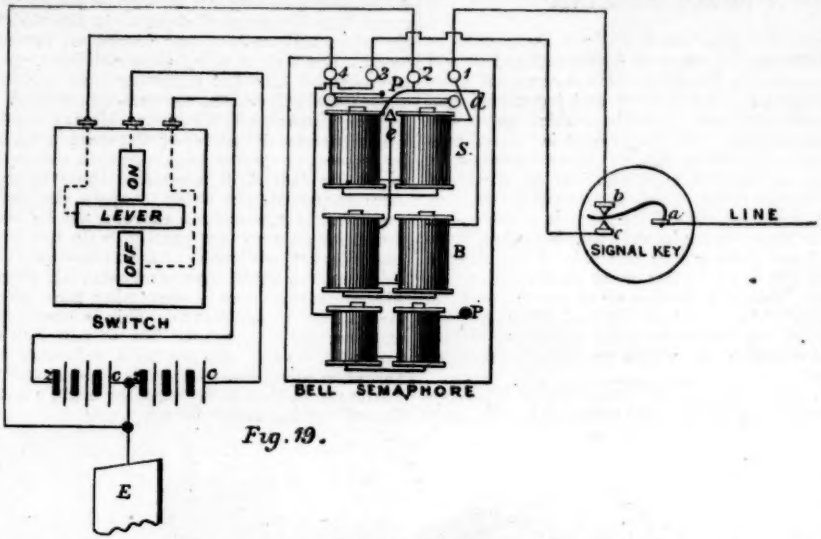


Fig. 19.

to danger, as shown in figure 20. The action of the arm should be carefully observed, as it is upon its arrangement that the superiority of the instrument is based. When the rod *i* was carried over by the induced magnet from the dotted position to that shown by the continuous line, it carried with it the arm *k* and the pin *h* to the horizontal position shown. The arm is now held in its position of *danger* by means, first, of the rod *i*, and, secondly, by means of the armature *f*.

The block signal has now to be acknowledged, which is done by pressing the signal key so as to bring the line spring *a*, into contact with the lower contact *c*. A current now flows from whichever set of batteries is in connection with the lever of

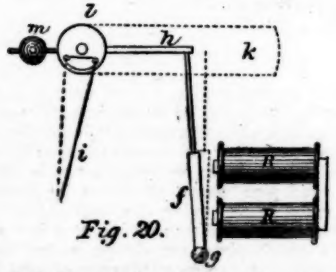


Fig. 20.

the switch (fig. 19) through it to No. 4 terminal of semaphore to P; and from P, through the small coils R, by way of terminal No. 3, to *c* of signal-key, and so on to the distant station. In passing through R it attracts *f*; but the arm being held at danger by the rod *i*, its position is unchanged, and the armature *f* falls back to its position of rest, as the slot until it takes up that position. The arm still remains raised to *danger*, being held in that position by the armature *f*. That the line is clear has been indicated by an oral signal—three beats on the bell. This is recognised by the signalman and acknowledged; but here, *in acknowledging the signal, the arm is released*. The current again passes through the coils R, the armature *f* is attracted, and assumes the dotted position, and the arm, now deprived of its support, falls to all clear.

It will be seen that every outgoing current passes through the coils R before arriving at the signal-key That the nature of the current to be sent is governed by the switch, and that every incoming current simply passes through the semaphore coils S, the armature of which for every current passed completes the bell circuit, and so repeats itself by a stroke on the bell.

On the face of the bell is an indicator operated in the same manner as that already described under Mr. Preece's three-wire system. Its object is to indicate the position of the arm at the distant station.

By the combined action required to lower the arm signal to the *all clear* position, the possibility of the signal being reversed by contacts or by an atmospheric current is most completely guarded against. All single wire instruments of this nature must necessarily be worked upon an open circuit, or momentary current principle; and during such time as the wire is not employed by the transmission of the regular signals required for working the line, it remains open to any others, whether conveyed to it from other wires or by lightning. Such foreign currents, to a great extent, actuate the signals the same as the appointed current, and

this means of overcoming the mischief which such an action might have cannot be too highly regarded.

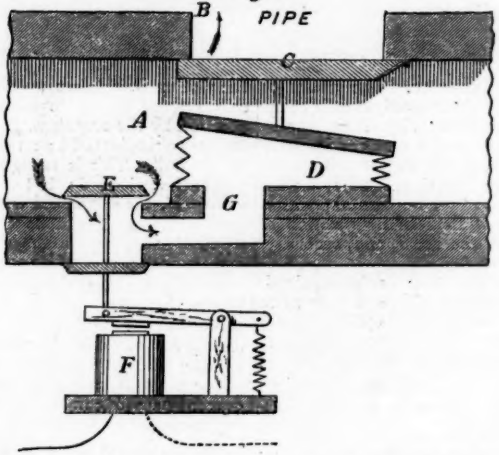
NEW APPLICATIONS OF ELECTRICITY TO ORGAN BUILDING.

A CONCERT organ has recently been erected in Chickering-hall, corner of Eighteenth-street and Fifth-avenue, in this city, which is remarkable for the numerous entirely novel and ingenious electrical and pneumatic inventions which enter into its construction. The instrument is one of considerable magnitude, having three manuals, a compass of 58 notes, 29 pedal notes, 33 stops, and the necessary couplers and mechanical accessories. So far as the location of its parts is concerned, it is really three organs in one; that is to say, a portion of the pipes are on one side of the stage, a portion are some 60 feet away on the other side, while a complete though small organ, used for echo effects, is placed on the roof of the hall, and about 175 feet distant from the single set of keyboards at which the entire apparatus is manipulated.

The portion of the instrument which is directly in rear of the keyboards is provided with pneumatic levers, so that the pressure on a key, instead of acting directly upon the valve of the pipe to be sounded, opens a valve which admits air into a small bellows. The latter, in its movements, actuates the pipe-valve, and thus performs the heavy work, so that the merest touch is sufficient to move the key. With the exception of this ingenious, pneumatic device, all the rest is directly mechanical, and, since it does not differ from the usual church-organ arrangements, needs no further reference. In the other two organs, however, are found the curious electro-pneumatic inventions which have seemingly revolutionized the art of organ building, for by their aid not only can new effects be produced, but one or a dozen organs can be played at once, and all their stops perfectly controlled, and this irrespective of whether they are located within ten feet or ten miles, or in fact any distance, from the player.

We propose to explain, by the aid of the annexed diagrams, first, how the pipes are sounded through pressing the keys, and, second, how the stops are manipulated. For the benefit of those unfamiliar with organs, it may be stated in advance that, by means of stops, air is admitted from the main bellows into any desired set or sets of pipes. Each set of pipes gives a different quality of tone, and thus the performer may select just such sounds (flute-like, trumpet-like, &c.) as best suit the character of the music. Having regulated his instrument by adjusting the stops, his fingers, by pressing the proper keys, open the valves leading to the individual pipes, and thus the instrument is played. In order to apply electricity to the object first mentioned above, it will be obvious that the keys must act exactly as do the keys of an ordinary telegraph instrument—that is, on being pressed down, they must establish a current which, passing over a connecting wire, actuates mechanism at a distance. This is precisely the case, so that the organist has no power to exert beyond the very light pressure necessary to so move the keys. Each key controls its circuit; and as the mechanism is the same for each, a description of one will suffice for all.

Fig. 1.



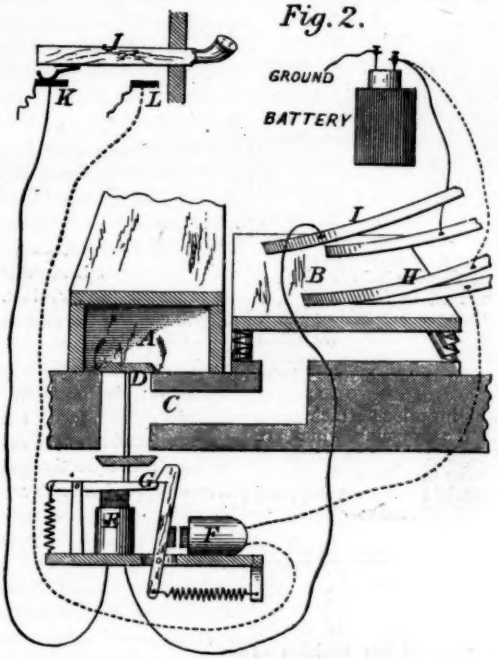
In the diagram, Fig. 1, A is a part of the air chamber, in which air, led by an air trunk from the air bellows, is kept compressed. B is the pipe corresponding to the key whose operation we are considering. There is an opening between the air chamber and pipe, closed, as shown by the valve, C. Attached to this valve is a small bellows, D. Through the bottom of the air chamber is another orifice, in which plays the double valve, E, the stem of which is continued downward, and is attached to the pivoted armature of the electro-magnet, F. Said armature is provided with a spiral spring, the effect of which is to hold it away from the magnet, and so to shut the lower part of valve, E, while holding the upper part open. This being the case, a portion of the compressed air in A will pass under the valve, but, being unable to

escape at the orifice below, will enter the channel, G, and so ascend into the bellows, D. There will therefore be a constant equilibrium of pressure about the bellows, and thus the valve, C, will be pressed tightly shut against its seat.

When, however, the key is pressed, then the circuit is established, and the magnet, F, becoming excited, draws down its armature, thus shutting the upper part of valve, E, and closing the lower part. The air in the bellows, then being free to escape through the passage, G, cannot equilibrate the pressure in the air chamber, and hence the bellows closes, and at the same time pulls down and opens the valve, C. A blast of air is then free to enter, and so sound the pipe, This state of affairs holds as long as the key is held down; but the instant it is released, the circuit is broken, and the various parts regain their normal position.

Fig. 2, A is an air chamber or wind box, fed as before from the main bellows. The small bellows, B, in this case, is located outside of the chamber, but communicates with it by the passage, C, in which is a double valve, D, similar to valve, E, in the preceding diagram. When the upper part of valve, D, is raised, and its lower part closed, there is a free passage for the air to pass from the wind box and into the bellows. When the valve is lowered, as represented, there is a clear passage from the bellows to the outside air. The stem of valve, D, is connected with an electro-magnet, E, arranged as previously described. There is, besides, another magnet at F, which controls a moving armature, G, one end of which forms a latch, and engages with the armature magnet, E. On top of the bellows are two pairs of springs, one pair, H, being in control only when the bellows is

Fig. 2.



The apparatus is extremely sensitive, and in its prompt action even surpasses the damper movement of a pianoforte; so that, in fact, the quickest passages and shortest notes can be played with a clearness, crispness, and brilliancy hardly otherwise attainable. Of course the intervening distance between this mechanism and the keyboard is practically immaterial so long as there is sufficient battery power. In the echo organ, previously referred to as located in the roof of the building, six Leclanché cells are found amply sufficient, although there are some two miles of connecting wires. This very light battery power required, in fact, is characteristic of the whole instrument.

Having seen how each key is worked, we now pass to the means whereby the wholeset of 58 keys is caused to control any desired set of pipes. In down, the other, I, being in like condition only when the bellows is inflated. J is the top in the organ, on the lower side of which is a switch which comes in contact with one or the other of the metal plates, K and L, according as the stop is pushed in or drawn out. The lead of the circuits is first from plate, K, to magnet, E, thence to the upper spring of pair, I: from the lower spring of same pair to the battery. The second circuit passes from plate, L, to magnet, F, to lower spring of pair, H: from the upper spring of same pair to the battery. The object is to move the bellows, and this last moves a series of switches oscillating on a horizontal axis, so as to establish connection in 58 key circuits at once. When the stop is pushed in as shown, there is obviously no connection with the battery, because of the pair of springs, I, being

separated. Supposing, however, the stop to be drawn out, then the switch on its lower side comes in contact with plate, L, the current passes and excites the magnet, F, which draws back its armature, G, and so releases the armature of magnet, E, the current of course continuing through the pair of springs, H, and so to battery. But the effect of releasing the armature of magnet, E, is to raise the valve, D, so that, as before stated, the air from the wind box is allowed to pass through the passage and into the bellows. The latter then rises, throwing over the 58 switches, and so establishing the connection of the keys. But as this rising continues, the springs, H, separate. The circuit is thus broken. At the same time the pair of springs, I, come in contact. The bellows remains, however, inflated, because the position of valve, D, remains unchanged, no circuit being complete through the springs, I, and magnet, E, until the stop pushed in establishes connection with plate, K. Consequently the bellows will stand full, and thus push the switches into action as long as the stop beside the keyboard is drawn out. When that stop is pushed in, the circuit closes, magnet, E, is excited, and valve, D, drawn down, cutting off any further supply of air to the bellows, and opening an escape for its contents. As valve, D, falls, the catch on armature, G, slips over the armature of magnet, E; and as the bellows descends, springs, I, once more separate, and thus the parts are again brought to the condition shown in the diagram.

It will be observed that this is all done with an open circuit: that the circuit, in fact, is always open, except just when changes are taking place, so that, with a battery like the Leclanché, which stands out of operation when there is no circuit, the exhaustion of the same is very slow, and the cost consequently light.

There are various other ingenious attachments of less importance than the foregoing, which are hardly necessary to be described. The credit of the inventions belongs to the builder of the organ, Mr. Hilborne L. Roosevelt, of New York City, and at some future time we shall probably recur to them again.—*Scientific American.*

Notes.

Our readers will regret to hear that Mr. George Preece, M.S.T.E., has resigned his position of Secretary to the Society of Telegraph Engineers. Mr. Sivewright has consented to act *pro tem.* until a permanent Secretary is appointed.

The attention and consideration shown by the members of the Institution of Civil Engineers to foreign professional brethren when visiting our public works and engineering establishments has been recently recognised by the King of Portugal, who has conferred on the Secretary of the society, Mr. James Forrest, the insignia of a Commander of his Military Order of Jesus. On a former occasion the Emperor of Brazil appointed Mr. Forrest a Knight of his Imperial Order of the Rose.

Mr. Walsh, Divisional Engineer of Postal Telegraphs, delivered a lecture on the electric telegraph, at a *conversazione*, at Stretford, on the evening of the 24th ult., which was very largely attended. The duplex system of telegraphy was exhibited and explained, and a vote of thanks was given to Mr. Walsh for his lecture.

We have received the following letter from the secretary of the Direct United States Cable Company (Limited.)

Sir,—I beg to inform you that this company's Torbay New Hampshire Cable is now repaired, and is in perfect working order. My directors have made arrangements to keep the steamship *Faraday* on the coast of Nova Scotia, pending the acquisition of a repairing steamer by the company. It appears that the last break was caused by cutting the cable with an axe or hatchet.—I am, Sir, your obedient servant, CHARLES C. CLARKE, Secretary, Palmerston-buildings, Old Broad Street, London, E. C., 1st March.

The following appeared in the *Daily News* of the 2nd:—We have received from the Direct United States Cable Company the following copy of telegram from its representative on board the steamship *Faraday*, on picking up the fractured end of the New Hampshire-Torbay cable, broken on the 23rd January last. The telegram seems fully to confirm the statement that there has been foul play in the matter:

"End of eastern piece up at 14 to 1 this morning, lat. 42.45; depth nearly 100 fathoms; damage caused by cutting with axe or hatchet; marks of three or four blows. Cable apparently raised upon anchor; subsequently severed; no natural chafing. Wires abraded on under side of bend; eight cut through evenly; two broken after being weakened by hacking. Condition excellent. Compound off for 12 inches from each end. Malice or wanton recklessness unquestionable. When cable raised it might easily have been slipped."

Commenting on the report of Sir W. Thomson and Mr. Bramwell, the *Daily News* makes the following remarks:—It follows, then, from this report, that very probably a new kind of piracy has commenced on the high seas, which the leading commercial nations should make arrangements as speedily as possible to check. Both for the sake of protecting most valuable property, and on account of the public interest in keeping open cable communications, means should be devised to keep an efficient police on the high seas, so as to prevent attacks on cable property. As the attacks are on property not under any flag, it may perhaps be necessary to extend by international convention the definition of piracy, but it has certainly become expedient, after the evidence now sup-

plied, that some action should be taken and the pirates hunted down.

Since the 13th of February all the offices of the Spanish provinces of Gerona, Barcelona, Lerida, Tarragona, Castellon, and Ternel, which had been closed through the Civil War, have been re-opened for work. The international service has also been re-established by the Franco-Spanish frontier of Perpignan Junquières. This will, no doubt, affect the receipts on the Barcelona and Marseilles cable belonging to the Direct Spanish Company, but to what extent remains to be seen. The cable has been well-worked, and has had an excellent and well-deserved traffic, and may yet be able to compete with the French and Spanish land lines. On the other hand, the receipts on the Santander line to England will, as soon as commerce is re-established at Bilbao in its old state, increase considerably.

In our last we mentioned that the Direct Spanish cable had been repaired in the s.s. *International*, Capt. Hayward. The work has been carried out by Mr. Benest, who was second Engineer on the laying of this cable, and has had considerable experience in cable work. The work was near a dangerous coast with a heavy Atlantic swell rolling in on it, and as another cable, belonging to the Spanish Government, between Santander and Bilbao runs parallel with and close to the cable repaired, the successful repair of the cable, without injury to the Government cable, does great credit to those engaged in the work at this time of the year.

The cable between Calais and Denmark has been for some weeks broken down, and the steamer *Caroline* is working at the repairs. Why this cable was ever laid seems difficult to imagine, as it runs parallel to the coast of countries in which numerous inland telegraph lines between France and Denmark exist. It must cross, at right angles, some eight or ten telegraph cables between this country and the continent, and all crossings of cables are objectionable, as if the crossed cables have to be raised, it would be difficult to do so without breaking or cutting one of the cables.

The Australian and New Zealand cable has been laid successfully by the Telegraph Construction Company. This cable is of a novel pattern. Instead of an outer sheathing of iron wires touching one another, as in the pattern of the Mediterranean deep sea cables, or of wires covered each separately with hemp, as in the Atlantic cables, we have alternately a wire and a hemp strand. This makes the cable cheaper at first cost, but we doubt whether it will be cheaper in the end to the company for whom it has been laid.

The steamship *Edinburgh*, which laid a portion of the cable, has been purchased by the "Eastern Extension and Australian Company" for £15,000 from the Telegraph Construction Company, and will remain out as a permanent cable repairing ship. Permanent repairing ships are a step in the right direction, but we cannot say that in this case the buying Company have been judicious in the selection of a ship, notwithstanding that they have a ship of 2,315 gross tonnage for £15,000. She is not a spar deck ship, and yet for a cable ship, a spar deck, so as to give plenty of room below, is almost a necessity. If she is a sound ship with compound engines and fully fitted with tanks and machinery she should be worth at least three times the price. The jump the company have made from the miserable little *Agnes*, the ship they have hitherto had for their former lines, to a ship of 2,315 tons is extreme, and there is something suspiciously small about the amount of money paid for the *Edinburgh*, which savours of getting rid of a broken down old horse for a song. We believe the selection of this ship as a repairing ship was in no way due to the engineers of the Extension Company. Most likely it was a matter arranged entirely between the Chairman and Managing Directors of the Companies with the advice, no doubt, of some "intelligent boatswain

The Direct United States Company's Torbay, New Hampshire, section is repaired. The cable was found cut with a hatchet. It is nothing new to find cables in shallow seas cut to clear nets and anchors; but the depth of one hundred fathoms, in which this was found cut, is greater, we believe, than any previous experience has shown.

The *Faraday* is to be kept out for the present as a repairing ship until the Company get one of their own. It is most strange that it should only now be dawning on the directors of the Direct United States Company that a repairing ship is necessary. With their opportunity of profiting from the experience of other companies they might have built the most perfect repairing ship by this time, and saved a considerable sum of money.

The Brazilian Submarine is another company without a repairing ship. These two companies are the only large companies without repairing ships. We suppose both companies will keep putting off the evil day until, under pressure of a break-down, in a hurry they buy some imperfectly arranged old tub, with the machinery crowded, not enough tanks and separate coiling spaces, and no room for the extra crew and stores.

A permanent repairing ship or cable ship should have plenty of room between decks for crew, stores, and men to work at splices, &c., and have

plenty of tanks—she cannot have too many—besides numerous other arrangements for facilitating the work. Yet when a new ship is built or bought she generally is quite devoid of any of these qualities.

The traffic receipts of the Direct Spanish Telegraph Company for the month of February were £679 7s. 9d., against £1,104 1s. 8d. for the corresponding period of last year. The Santander Lizard section was interrupted from the 3rd to 27th of February.

The traffic receipts of the Great Northern Telegraph Company for the month of February were £303,090fr. as against 254,643fr. for the corresponding period of last year.

At an adjourned meeting, on February 23rd, of the Western and Brazilian Telegraph Company, the accounts for the year ending 30th September last were adopted.

At the meeting, on February 29, of the Mediterranean Extension Telegraph Company (Limited), the usual half-yearly dividend on the Eight per Cent. Preference Stock, and a dividend at the rate of 3 per cent. per annum on the ordinary shares were declared, and £500 was carried to the reserve fund, raising that fund to £8,488.

The traffic receipts of the Brazilian Submarine Telegraph Company (Limited), for the month of February, amounted to £12,443, as against £9,857 for the corresponding period of 1875.

The number of messages passing over the lines of the Cuba Submarine Telegraph Company (Limited), during the month of February was 2,642, estimated to produce £2,500, against 2,080 messages, producing £2,195, in the corresponding month of last year.

The Eastern Telegraph Company's traffic receipts for the month of February amounted to £37,044, against £32,765, in the corresponding period of 1875.

The Traffic receipts of the Eastern Extension, Australasia, and China Telegraph Company (Limited) for the month of February amounted to £19,027, and to £16,415 for the corresponding period of 1875.

The directors of the Eastern Telegraph Company (Limited) invite subscriptions for an issue of 6 per cent. first preference share capital in 70,000 shares of £10 each at par. The new capital is required for the duplication of the company's Red Sea and Indian Ocean cables.

The directors of the Brazilian Submarine Telegraph Company (Limited) on March the 3rd, declared an interim dividend of 2s. 6d. per share or 5 per cent. per annum, free of income tax, for the quarter ending 31st December, 1875, and payable on Saturday, the 25th instant.

The report of the Indiarubber, Guttapercha and Telegraph Works Company (Limited) has been issued to the meeting on the 14th inst., and shows that the result of the year's trading is a net profit of £42,617, which the Directors propose to apply to the reduction of the amount of £66,799, standing at the debit of profit and loss account on 31st December, 1874. The sum of £8,724 has been written off from the Company's property for depreciation as usual. The sales for the past year, it is mentioned, not reckoning the Peru and Chili Cables, amounted to £291,001, as against £258,854 for the year 1874, and it is added that the general business of the Company has been fairly remunerative.

The cable from Vigo to Carcavellos broke down on the 5th of February.

The Para Pernambuco cable broke down on the 13th of November, and was repaired on the 18th of February, but on the 24th it broke down again.

The report of the *Great Eastern* Steamship Company (Limited) states as follows:—"The directors, in submitting the accounts for the past year are glad to report that, as explained at the special general meeting, held on 8th December last, all matters connected with the defalcations of the late Secretary have been settled, and, after paying a dividend of 5 per cent., declared 14th August last, there is now a balance to credit of Revenue Account of £7,784, and a cash balance on capital account of £13,284. Until the ship is again employed, the directors think it better not to reduce the balance in hand by paying a dividend. The ship was delivered to this Company at Milford Haven by the Telegraph Construction and Maintenance Company in August last, and she has since been placed upon a gridiron that has been constructed for her within the works of the proposed Milford Docks, which are now in progress, and the directors trust that in a short time a graving dock will be completed sufficient for her accommodation. The hull is now being well cleaned and painted, and such other repairs done to her as will fit her for sea. Several proposals have been made to the directors for the employment of the ship, but as yet no arrangement has been concluded: the matter is having the best consideration of the directors."

The *Olstereichische Landwithschafthiche Wochenblätter* states that Dr. Virson, Superintendent of the Italian Experimental Silk Farm at Padua, has

discovered that the hatching of silk-worm eggs, of suitable age, may be accelerated by a period of 10 or 12 days, and a yield of at least 40 per cent. of silk-worm caterpillars secured, by exposing the eggs to a current of negative electricity from a Holtz machine for a space of 8 or 10 minutes. It is suggested that the same method might perhaps prove useful in hastening the germination of various seeds.—*Quarterly Journal of Science.*

In a recent number of *Les Mondes*, the Abbé Moigno directs attention to hygienic application of electricity. From his remarks, it would appear that Dr. Pozzioli has advised a system of "electrical gymnastics." The exact nature of these gymnastics is not stated; but it is mentioned that recent trials, in the presence of a committee appointed by the Prefect of the Seine, upon 21 school children of known physical weakness and mental debility, resulted in improved respiration and appetite, as well as in improved mental conception and an increase in height, weight, and chest-measurement. These beneficial effects are said to have remained three months after the conclusion of the course. *Les Mondes* also states that the same Dr. Pozzioli has succeeded in proving that electricity may be usefully employed as a sedative in nervous affections and certain acute forms of disease.

The value and importance of the "Catalogue of Scientific Papers," compiled and published by the Royal Society, in six volumes 4to., are acknowledged wherever science is cultivated. It is, so to say, a history of the science of the world from the beginning of the present century down to 1863, for it presents the titles of papers published in the Transactions of Societies and in scientific periodicals, in all languages, within the sixty-three years. But experimentalists have not been idle during the subsequent years. There has been, indeed, increased activity; and a great desire has been expressed for a continuation of the work. We feel sure that scientific men everywhere will be glad to learn that this desire is about to be gratified. The Royal Society have kept on with their self-imposed labour—a labour of love—and have recently sent to press the continuation of the Catalogue for another decade, 1864-1873. It is expected to form two volumes equal in bulk to those which have already appeared, and will probably be ready for publication by the end of the present year. The entire cost of compilation has been borne by the Royal Society. As some of our readers will remember, the cost of printing the first six volumes was defrayed by a grant from the Treasury, at the time when Mr. Gladstone was Chancellor of the Exchequer in Lord Palmerston's Ministry. The present Government have not been less appreciative than their predecessors, and the expense of printing the continuation of the Catalogue will be paid by the Treasury, and thus a national character will be given to a work which will confer a lasting benefit on the science of the world.—*Athenæum*, Feb. 26.

M. du Moncel has just published the third edition of the fourth volume of his "Exposé des Applications de l'Électricité."

To all who are interested in the applications of electricity, a paper by M. Tresca, in the *Comptes Rendus* for the 31st of January will have much interest. It is "Comptes Rendus des Expériences faites pour la Détermination du Travail dépensé par les Machines Magnéto-Electriques de M. Gramme, employées pour produire de la Lumière dans les Ateliers de MM. Sautter et Lemonnier." —*Athenæum*, Feb. 26.

Mr. Crookes's remarkable experiments are naturally attracting much attention. Dr. F. Neesen and M. Poggendorff have articles upon the "Radiometer" in *Poggendorff's Annalen*, the conclusion arrived at being that the experiments have conducted to the realization of an apparatus, thermo-electric in character, possessing extraordinary sensibility with respect to the heat-rays.

Lord J. Manners in the House of Commons on Mar. 6th, stated that for the reason which he assigned the other day, the telegraph cards had ceased to exist, but the public would be furnished with telegraph message forms, which could be deposited in the pillar post boxes, whence they could be collected and despatched. For obvious reasons the latter were much less likely to be mistaken for letters, than were the old telegraph cards to be mistaken for halfpenny cards.

The Report of the Directors of the Direct Spanish Telegraph Company (Limited) to the meeting of the 21st, states that the profits during the half-year ending 31st December, 1875, amount to £7,352 15s. 8d., out of which they propose to pay a dividend, at the rate of five per cent. on the ordinary shares.

THE BAKERIAN LECTURE.

An Account of several new Instruments and Processes for determining the Constants of a Voltaic Circuit.

By CHARLES WHEATSTONE, Esq., F.R.S.,
Professor of Experimental Philosophy in King's College, London, Corresponding Member of the Academy of Sciences at Paris, &c.

Received June 15.—Read June 15, 1843.

(Concluded from page 73)

SECTION 16.—*The Differential Resistance Measurer.*—The method of determining the resistance of metal wires and other conductors of electricity by

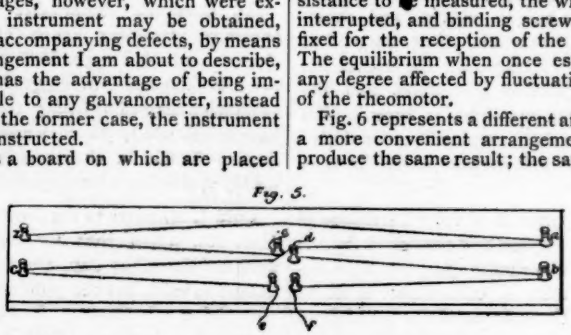
means of the rheostat, described in Section 9, is inapplicable when small differences are to be observed. If, for instance, a short length of wire has to be examined, its resistance is so small compared with the other resistances in the circuit, including that of the battery, that whether it be interposed or not, no change is observable in the deviation of the needle; and, even if greater lengths of the conducting substance be employed, fluctuations in the power of the battery frequently render the observation uncertain.

The differential galvanometer proposed by M. Becquerel, had it been an instrument as practically as it is theoretically perfect, would have enabled us to ascertain very minute differences of resistance with great facility. But it is almost impossible so to arrange the two coils that currents of equal energy circulating through them shall produce equal deviations of the needle in opposite directions, the consequence of which is that the standing of the needle at zero is no indication of equality in the currents. This and other defects have prevented the differential galvanometer from coming into use.

All the advantages, however, which were expected from this instrument may be obtained, without any of its accompanying defects, by means of the simple arrangement I am about to describe, which, moreover, has the advantage of being immediately applicable to any galvanometer, instead of requiring, as in the former case, the instrument to be peculiarly constructed.

Fig. 5 represents a board on which are placed

Fig. 5.



four copper wires, *Z b*, *Z a*, C *a*, C *b*, the extremities of which are fixed to brass binding screws. The binding screws *Z*, C are for the purpose of receiving wires proceeding from the two poles of a rheomotor, and those marked *a*, *b* are for holding the ends of a wire of a galvanometer. By this arrangement a wire from each pole of the rheomotor proceeds to each end of the galvanometer wire, and if the four wires be of equal length and thickness, and of the same material, perfect equilibrium is established, so that a rheomotor, however powerful, will not produce the least deviation of the needle of the galvanometer from zero. The circuits *Z b a* C *Z*, and *Z a b* C *Z*, are in this case precisely equal, but as both currents tend to pass in opposite directions through the galvanometer, which is a common part of both circuits, no effect is produced on the needle. Currents are, however, established in *Z b* C *Z*, and *Z a* C *Z*, which would exist were the galvanometer entirely removed. But if a resistance be interposed in either of the four wires, the equilibrium of the galvanometer will be disturbed; if the resistance be interposed in *Z b* or C *a*, the current *Z a b* C *Z*, will acquire a preponderence; if it be inserted either in *Z a* or C *b*, the opposite current, *Z b a* C *Z* will become the most energetic. If the resistance interposed in the wire be infinite, or, which is the same thing, if the wire (which we will suppose to be C *b*) be removed, the energy of the current passing through the galvanometer will be that of a partial current *Z b a* passing through one of the wires plus the galvanometer wire; the path of the diverted portion of the current being *Z a*. According to this disposition, the force of the original current

$$= \frac{E}{R + 2r + g}$$

and that of the partial current acting on the galvanometer

$$= \frac{E\,r}{R\,(3\,r + g) + 2\,r^2 + r\,g};$$

R being the resistance of the rheomotor, *r* that of a single wire, and *g* that of the galvanometer.

The equilibrium having been disturbed by the introduction of a resistance in one of the wires, it may be restored by placing an equal resistance in either of the adjacent wires. For the purpose of interposing the measuring resistance and the resistance to be measured, the wires *Z b* and C *b* are interrupted, and binding screws, *c*, *d*, and *e*, *f*, are fixed for the reception of the ends of the wires. The equilibrium when once established is not in any degree affected by fluctuations in the energy of the rheomotor.

Fig. 6 represents a different and, in some respects a more convenient arrangement of the wires to produce the same result; the same reference letters are employed, and the preceding observations apply to it equally.

Slight differences in the lengths, and even in the tensions of the wires, are sufficient to disturb the equilibrium: it is therefore necessary to have an adjustment, by means of which, when two exactly equal wires are placed in C *a* and *Z a*, the equilibrium may be perfectly established. For this purpose, in the instrument, fig. 6, a piece of metal

Fig. 6.

n, connected with the binding-screw *b*, is inlaid in the board, and another piece of metal *m* moves round *n* as a centre, whilst its free extremity always rests on the wire. According as the movable piece of metal makes a greater angle with the fixed piece, the resistance of the path *Z b* is diminished; if, however, the equilibrium is disturbed because the resistance in C *b* is too great,

the moveable piece of metal must be placed on the opposite side of the fixed piece.

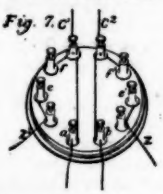
No fixed dimensions can be assigned to these instruments. The boards of those I employ are fourteen inches long and four inches wide, and the wire is copper $\frac{1}{10}$th of an inch in diameter. A single voltaic element of large surface will produce a more considerable effect than a battery of small elements.*

A thermo-electric arrangement, or a magneto-electric machine may be substituted tor the voltaic element or battery; and a voltameter or any other description of rheometer may in some cases supply the place of the galvanometer. It is scarcely necessary to state that these instruments are not adapted to measure the resistances of substances capable of undergoing chemical changes from the action ot an electric current, on account of the contrary electro-motive forces which arise under such circumstances.†

Section 17.—Another differential arrangement, which will be found useful in some circumstances, may be worth mentioning; it is much more sensible than the preceding, but as the equilibrium indicated is that between two currents generated by independent rheomotors, instead of diverted portions of the same current as in the instruments previously described, the state of equilibrium will be disturbed by every fluctuation, whether of the electro-motive force, or resistance of either of the rheomotors; it can therefore only be safely employed when these are perfectly constant, or when the object is not to measure resistances, but to observe the comparative changes in two rheomotors.

Fig. 7 represents a circular board on which are

Fig. 7.



fixed ten binding screws; the wires proceeding from one of the rheomotors are to be attached to C^1 and Z^1, those from the other to C^2, Z^2, and the ends of the galvanometer wire are to be fixed to *a* and *b*. The two currents, $C^1\ a\ b\ Z^1$ and $Z^2\ a\ b\ C^2$, tend to pass through the galvanometer wire in opposite directions. When two equal wires are interposed between *e f* and *e' f'*, if the opposing currents be equal, perfect equilibrium is established in the galvanometer wire, and the needle remains at zero. But if the force of the current in either of the rheomotors varies, or, if while the force of the two rheomotors remains constant, the slightest difference is occasioned in the resistance of either of the wires interposed between *e f* or *e' f'*, the equilibrium in the galvanometer wire is disturbed and the needle is deflected.

Section 18.—It would greatly facilitate our quantitative investigations if we had a certain and ready means of ascertaining what degree of the galvanometric scale indicated half the intensity corresponding to any other given degree. The properties of diverted currents, established by the theory of Ohm, and fully confirmed by experiment, enables me to propose a simple method by which this object may be completely attained.

If a wire of the same length, thickness, and conductability as that of the galvanometer be placed so as to divert a portion of the current from it, it is obvious that one-half of the current will pass through the galvanometer wire, and the other half through the diverting path. Though it simplifies the consideration to suppose the extra wire to have the same length, diameter, and conducting power, it is easy to see that the same result follows if the two wires present the same resistance which they do whenever $s'\ c'\ l = s\ c\ l'$. If the added wire produced no alteration in the intensity of the principal current, one-half of the former force would act upon the galvanometer; but this is not the case, the addition of the wire produces the same effect as doubling the section of the galvanometer wire would do, and the total resistance of the circuit is therefore diminished. If the strength of the original current when it passes wholly through the galvanometer

$$= \frac{E}{R + r}$$

(*r* being the resistance of the galvanometer wire, and R all the other resistances in the circuit),

$$\frac{E}{R + \frac{r}{2}},$$

will be the strength of the principal current when the extra wire is added; if now an additional resistance $= \frac{r}{2}$, that is to say, a wire whose resistance is equal to half that of the galvanometer wire, be added to the principal portion of the circuit, the intensity will be again

$$\frac{E}{R + \frac{r}{2} + \frac{r}{2}},$$

and the force acting on the galvanometer will be exactly half what it was at first.

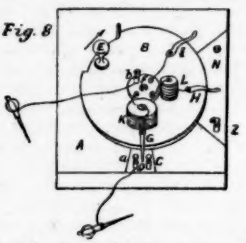
The construction and use of the instrument (fig. 8) will now be easily understood. A is a square piece of wood, having two insulated pieces of brass, D, N, inlaid on its surface, on which are fixed the binding screws C, Z, and *a*; B is a circle also of wood, moveable round its centre; upon this moveable circle are fixed the insulated piece of brass F, with the binding screw *b* upon it, and three springs G, H, I, the free ends of which press

* When a single element of Daniell's battery, 6 inches high and 3½ inches diameter, is employed, and two copper wires two feet long and $\frac{1}{10}$th of an inch diameter are interposed in the instrument, an augmentation of the tenth of an inch in one occasions a deviation of 2° in the galvanometer needle. This will suffice to show the accuracy with which resistances may be measured by this instrument.

† Mr. Christie, in his "Experimental Determination of the Laws of Magneto-Electric Induction," printed in the Philosophical Transactions for 1833, has described a differential arrangement of which the principle is the same as that on which the instruments described in this section have been devised. To Mr. Christie must, therefore, be attributed the first idea of this useful and accurate method of measuring resistances. Another differential arrangement, proposed also in the same memoir, is analogous to that which forms the subject of the following section.

on the board A. A coil of wire K, the equivalent resistance to the wire of the galvanometer, measured by the process described in section 16, is connected by its two ends with the brass plate F and the spring G; and another coil, L, the resistance of which is one-half that of the former, is similarly interposed between the brass plate and the spring H. A short wire immediately connects

Fig. 8



the plate F with the spring I. E is a nut or pin by which the moveable circle is moved through a small arc.

The wires proceeding from the poles of a rheomotor being connected with the binding screws C, Z, and the ends of the galvanometer wire being attached to the screws *a* and *b*; in the position of the instrument represented in the figure, the springs G and H resting respectively on the insulated pieces of brass D and N, the principal portion of the current passes through the resistance coil L, and the current is afterwards equally divided between the coil of the galvanometer and the resistance coil K. But when the circle is moved in the direction of the arrow, the springs G, H leave the brass plates, and rest on the wood, while the spring I is brought into contact with the plate E; both of the resistance coils are now thrown out of the circuit, and the current passes wholly through the wire of the galvanometer.

It is almost unnecessary to state that this instrument can only be used in conjunction with the galvanometer to which its resistance coils K and L have been adjusted.

In some cases, when an experiment has been performed with a current of a certain degree of intensity, it is required to repeat it with currents of other degrees of strength, the proportions of which to the first current shall have been accurately determined. The instrument above described readily affords the means of doing this. It may thus be ascertained whether the electro-motive force in any particular combination varies or remains constant when the energy of the current changes.

Section 19.—*Process to determine the Degree of Deviation of the Needle Galvanometer corresponding to the Degree of Force; and the Converse.*—When the electro-motive force in the circuit remains constant, the force of the current is simply proportional to the resistance or reduced length of the circuit. If therefore the total resistance of the circuit, when the needle stands at 1°, be determined, and if then, by means of the rheostat and resistance coils, the resistance be successively reduced to $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{5}$, &c., the corresponding forces of the current will be 2, 3, 4, 5, &c. Conversely, if the reduced lengths, *a*, *b*, *c*, *d*, &c., necessary to be removed from the circuit in order to advance the needle from each degree to the one next above it be successively ascertained, the forces corresponding to these successive degrees will be

$$\frac{1}{R}, \frac{1}{R-a}, \frac{1}{R-(a+b)}, \frac{1}{R-(a+b+c)}, \text{ &c.}$$

By the above processes the relations between the degrees of force and those of the galvanometric scale may be far more readily determined than by either of the ingenious methods of Nobili, Becquerel, or Melloni. When we consider the changes to which the needle of a delicate galvanometer, especially if it be astatic, is subject from the influence of strong currents, the vicinity of magnets, and, in a less degree, from changes of temperature, and in the intensity of the earth's magnetism, the importance of having an easy means of re-graduating the instrument, and of detecting the changes it has undergone, will not be esteemed too lightly.

ON THE ACTION OF HEAT IN MAGNETIZATION.

BY L. FAVÉ.

It has long been known that the magnetic state of a steel bar changes with the temperature. Coulomb, Kupffer, and other physicists have studied the very complex laws of the diminution of magnetic intensity: and the most marked consequence resulting from their experiments is, that by raising the temperature of steel to a certain point we cause it to lose definitely the magnetism it has received.

M. Jamin has recently demonstrated * that steel is capable of receiving considerable magnetization at a temperature at which it loses almost entirely that which it received when cold, while the magnetism of a bar magnetized when hot diminishes very rapidly, and in a very short time almost completely disappears.

We have investigated the variations of magnetic intensity by the method of Van Rees, which permits a speedy determination of the total quantity of free magnetism in a bar.

If a helix, formed of a few turns of copper wire wound round the bar, be slid quickly from the middle to a distance at which its influence is no longer sensible, the initial deflection of a galvanometer-needle, produced by the very feeble induced current resulting from the movement, measures sensibly the total quantity of free magnetism of the bar, we are assured that the earth's action is not sufficient to give an induced current that could disturb the result.

We operated on bars previously annealed, and cooled slowly, so that we could regard the changes of state as absolutely temporary, and the variations of temper did not complicate the phenomenon.

The bar to be examined is suspended horizontally to a copper rod, above a tube pierced with a series of apertures forming gas-jets close enough to heat the bar in a manner sensibly uniform throughout its length. This arrangement permits the magnetising-coil to be introduced without the bar ceasing, even when inside, to be under the action

* *Comptes Rendus*, December 22, 1873.

of the source of heat—an important condition for following from its commencement the phenomenon of loss. The current from a pile of ten Bunsen elements is caused to pass round the bar; then the coil is withdrawn; the helix of copper wire, protected by a non-conducting envelope, is afterwards introduced as far as the middle of the bar, and then suddenly withdrawn; the initial deflection of the needle of a mirror-galvanometer produced by this last movement is measured. The temperature of the bar was given approximately by a thermoelectric couple.

We thus observed that the quantity of residual magnetism slowly diminishes as the temperature of magnetization is increased; it is still considerable at incipient redness, but becomes insensible at a cherry-red heat.

The magnetism, which is rapidly lost if the bar is allowed to cool, is preserved at any temperature if the same calorific state is maintained—if not indefinitely, at least during a time so long that the very slow enfeeblement observed can be attributed to oscillations of temperature resulting from the difficulty of keeping a very high temperature perfectly constant. An augmentation or a diminution of temperature is accompanied by a loss of magnetism, which therefore does not depend on the temperature at which the bar was magnetized, but is a correlative phenomenon of the thermal state. The quantity of magnetism at a determinate temperature depends on the nature of the steel, the temperature of magnetisation, and changes of state subsequently undergone.

When the bar is heating, the magnetism diminishes according to a law which depends on the composition of the steel, but in a pretty regular fashion; when it is cooling, the law of the loss of magnetism is very different from that of the loss of heat. The temperature diminishes, as we know, at first rapidly, then less and less quickly, and can be represented approximately by Newton's formula,

$$\theta = e^{at}.$$

The magnetic loss is, on the contrary, very slow at the commencement, then augments very rapidly, to resume afterwards a decreasing value. The annexed Table gives the quantity of magnetism, measured from minute to minute, in a bar magnetized at about 350° C.:—

Times	0	1	2	3	4	5	6	7	8	9	10	60
Quantities of magnetism	29	29	28·8	28·7	27	19	12	8	6·5	5	4	1·5
Temperatures	350°			200°				100°				12°

We see that it remains nearly constant during three minutes, then loses in four minutes two thirds of its value, lastly diminishes less and less quickly, and when the bar has arrived at the ordinary temperature has only $\frac{1}{20}$ of its initial value.

When we vary the temperature of magnetization, the time during which the loss remains very slight goes on increasing as the initial temperature is raised, although the cooling is more and more rapid. Besides, the time is independent of that during which the magnetism has been kept constant by maintaining the temperature.

When a bar which was magnetized when hot has been allowed to cool and is again heated, we observe that the quantity of magnetism increases and may attain to three times the value which it had preserved, remaining nevertheless below that possessed by it at the time of its magnetization. This is similar to M. Wiedmann's observation concerning the magnetic moment of bars magnetized at 100°.

But in following the quantity of magnetism during the heating of the bar, it is seen to pass through a maximum, of which the temperature varies with the nature of the steel, but is always below the temperature of magnetization; if the heating is continued, the magnetism definitely vanishes. On leaving the temperature below that corresponding to the maximum, and letting the bar cool and then reheating it, the second maximum is found to be below the first, and so on. This property belongs solely to magnetism received at a high temperature and lost in consequeuce of cooling. When a bar which has received partial magnetization by contact with a magnet, or conserved after heating, is heated, the magnetism is seen to diminish more or less rapidly, but without there being any augmentation.

We have studied bars of divers compositions and different sections. Varying also the manner of heating, the quantities of magnetism conserved at the same temperatures have shown themselves to be different; but we have constantly observed these three phenomena:—

(1) The conservation of the magnetism at any temperature when that temperature is maintained constant;

(2) The diminution, at first slow, of the magnetism, becoming very rapid after a time variable with the temperature of magnetization;

(3) The augmentation of the quantity of magnetism remaining after cooling when the magnet is reheated.

The operations were performed in the laboratory of the Sorbonne.—*Comptes Rendus de l'Académie des Sciences*, Jan. 24, 1876, vol. lxxxii. pp. 276—278.

Proceedings of Societies.

PHYSICAL SOCIETY.

At the meeting of February 26, Prof. G. C. Foster, President, in the chair, the following candidates were elected members: the Rev. R. Abbay, and Mr. W. Bottomley, sen.—Mr. A. Haddon exhibited and described a form of tangent galvanometer, so arranged that, by the aid of an electric lamp, an image of the needle can be projected on the screen, and its deflections thus made evident to large audiences. Mr. O. J. Lodge described some investigations on which he has recently been engaged in reference to the flow of electricity in plane, bounded surfaces, in continuation of a paper read before the Society in the early part of last year, by Prof. G. C. Foster and himself. After some introductory considerations, he pointed out that all the conditions of the flow of electricity are known for any number of poles in an unlimited sheet. The problem then consists in reducing cases of poles in bounded planes to corresponding cases in the unlimited plane, so that the flow conditions on the bounding line may be the same in both cases. The determination of these data, however, for limited planes of certain forms presents considerable difficulty. In study-

ing questions of this natnre, there are two kinds of lines which must be considered. These are "equipotential lines," *along* which no electricity passes, and "lines of flow," *across* which no electricity passes. The boundary of any conducting surface will, of course, always be a line of flow, and, in a bad conductor, we can form an equipotential line by laying a band of copper in the required direction. If, therefore, in studying a surface of limited extent, in contact with an electrode, we can find a point, or points, outside the surface, such that, if they be made electrodes, the boundary line of the surface becomes a line of flow, we are at liberty to treat the surface as part of an infinite plane, and all the circumstances are therefore known. To take the simplest case, a straight line in an infinite surface will be a line of flow if equal sources be placed in pairs on the opposite sides of the line, so that one is the virtual image of the cther; but, if the components of each pair are of opposite sign, it becomes an equipotential line. To make a circle of radius (r) an equipotential circle, we require a source A within, and a sink B without, such that $CA \cdot CB = r^2$. To make it a line of flow, we require two sources, such that $CA \cdot CA' = r^2$, and an equal sink at C, the centre of the circle. The cases of an infinitely long straight strip, and of a surface bounded by two straight lines inclined at an angle O, were then referred to, and Mr. Lodge showed that the first requires an infinite number of external sources arranged on a straight line, and the second an infinite number on a circle, except when O is a sub-multipule of II, the number then becoming finite. Diagrams of the images for certain cases of triangles and squares were also shown. The dimensions of the electrodes in contact with conducting surfaces are not matters of indifference. In a plane bounded by straight lines, the electrodes within and without the boundary are of equal size; but when the boundary is a circle, the areas of electrodes vary as the squares of their distances from the centre. It was then pointed out that not only the poles may be reflected in this way, but also every point in the sheet; and if the lines of flow or of potential are drawn inside a given circle for any arrangement of poles, the lines outside can be immediately obtained from them by inversion with regard to the centre of the circle by means of a Peaucellier cell. The author then described the manner in which the principle of Wheatstone's Bridge can be employed for tracing out lines of equal potential. If A and B be a source and sink on a conducting ring, and P any point on the ring between A and B, and Q any point between B and A, then P and Q are of equal potential, whenever $\frac{PA}{PB} = \frac{QA}{QB}$. If now the wire under the point P be flattened out into a surface, the above expression holds good for a certain line on that surface, which is, therefore, an equipotential line. Similarly by flattening out the wire under the point A, the line for which the expression then holds good is a line of flow for a certain distribution of poles. At this point, the reading of the paper was adjourned to the next meeting of the Society.—*Athenæum.*

ROYAL SOCIETY.

At the last meeting of the Royal Society Dr. Siemens exhibited the instrument he has devised to ascertain the depth of the sea by a new means without using a sounding line. He has worked out the requirements, starting with the proposition that the total gravitation of the earth, as measured on its normal surface, is composed of the separate attractions of all its parts, and that the attractive influence of each equal volume varies directly as its density and inversely as the square of its distance from the point of measurement. The density of sea water being about 1·026, and that of the solid constituents composing the crust of the earth about 2·763 (this being the mean density of mountain limestone, granite, basalt, slate, and sandstone), it follows that an intervening depth of sea water must exercise a sensible influence upon total gravitation, if measured on the surface of the sea. Dr. Siemens showed how this influence can be proved mathematically in considering, in the first place, the attractive value of any thin slice of substance in a plane perpendicular to the earth's radius, supposing that the earth is regarded as a perfect sphere, of uniform density, and not affected by centrifugal force.

It was in 1859 that Dr. Siemens first attempted to construct an instrument based on these principles. The difficulties he then encountered he has since overcome, and the present instrument is the result of his latest work. He proposes to call it a bathometer, and it consists essentially of a vertical column of mercury contained in a steel tube having cup-like extensions at both extremities, so as to increase the terminal area of the mercury. The lower cup is closed by means of a corrugated diaphragm of thin steel plate, and the weight of the column of mercury is balanced in the centre of the diaphragm by the elastic force derived from two carefully-tempered spiral steel springs of the same length as the column of mercury. One of the peculiarities of this mechanical arrangement is that it is parathermal, the diminishing elastic force of the springs with rise of temperature being compensated by a similar decrease of potential of the mercury column, which decrease depends upon the proportions given to the areas of the steel tube and its cup-like extensions. The instrument is suspended, a short distance above its centre of gravity, in a universal joint, in order to cause it to retain its vertical position, notwithstanding the motion of the vessel; the vertical oscillations of the mercury are almost entirely prevented by a local contraction of the mercury column to a very small orifice. The reading of the instrument is effected by means of electrical contact, which is established between the end of a micrometer-screw and the centre of the elastic diaphragm. The pitch of the screw and the divisions upon the rim are so proportioned that each division represents the diminution of gravity due to one fathom of depth. Variations in atmospheric pressure have no effect on the reading of the instrument, but corrections have to be made for latitude. The instrument has been actually tested in voyages across the Atlantic in the *Faraday*, and the comparisons with Sir W. Thompson's steel wire sounding apparatus showed it was very reliable.

The paper concluded by pointing out many ways in which the instrument might be of use; among others was that of indicating approaching

danger if contour lines were first efficiently mapped.—*Iron.*

Reviews, &c.

A Handbook of Electrical Testing. By H. R. Kempe, Associate of the Society of Telegraph Engineers.

From a series of articles on testing which originally appeared in these columns, Mr. Kempe has produced an excellent little work on this subject. It is true much has been added to that which originally appeared in our numbers, but this makes the work of more value. We have now a book which, beginning with a simple test for the measurement of a resistance, passes on to the more complex tests used on measuring the resistance of the insulating sheath of submarine cables.

Resistance coils, the tangent, and Thomson's galvanometer and electronometer, shunts, keys, and condensers are described.

We have the measurement of the internal resistances of batteries and comparison of electromotive forces, the Wheatstone bridge, testing for faults, measurement with condensers, and measurement of high resistances; measurement of resistances by measuring the potential at different parts of the circuit; measurement of resistances by the fall of charge; joint testing; specific measurement; corrections for temperatures, &c.

In the measurement with condensers Mr. Kempe enters into the error pointed out by Mr. Clark, caused by the induced current produced in the coil by the needle itself, and gives a formula of his own for this correction different to Mr. Hockin's.

The measurement of the capacity of cables is not quite so fully treated as other parts, and we here miss Mr. Hockin's test without a condenser.

The correction for the loop test, so as to take into account the resultant fault caused by the loss through the insulation medium, is given. This correction does not appear in any other work that we know of. We believe this correction was first applied by, and is due to, Mr. Herbert Taylor, when testing some of the second Persian Gulf Cable, but that Mr. Kempe has improved it by making it applicable even if the resultant fault is not in the centre of the cable. All cables should be tested by the loop test to find the position of the resultant of their leakage, so that if a fault occurs this correction may be applied to the ordinary loop test, when such test can be applied.

In the chapters on corrections for temperatures, we miss the means of applying the corrections when two portions of the circuit differ in temperature. This often occurs in cable factories, where sometimes five or ten miles of core is added on in the factory to the cable in a colder tank. Some daily tests, as taken generally in our cable factories, placed down in the best order for facilitating the work, and worked out in logarithms, would have been an advantage to the learner, and, indeed, of use for easy reference to those whose duties may leave them some time without having to take tests, and then have suddenly to take them.

Taking the book altogether, it is a very excellent little work of reference, particularly for those who wish to learn the *rationale* of the various tests, as they are very clearly explained, and we hope it may receive the success it deserves.

THE "JASK HOWL."

Few of our readers have, perhaps, heard of the *Jask Howl*, a paper published in Kurrachee, by the staff of the Government Indo-European Telegraph in the Persian Gulf. We are not aware whether the paper is continued. There was in the numbers we have perused a medley of sound sense and fun highly creditable to the staff who thus endeavoured to amuse themselves, when living in the isolated and broiling hot stations of the Gulf. We extract an article from their "Debilitated Correspondent," and some poetry, from their number of Dec. 14, 1872.

(*From the Debilitated Correspondent.*)

The arrival of the *Witch** has occasioned a perfect turmoil in the station. The whole place is at sixes and sevens. Of course everything has been made to look neat, and the bungalow has been furbished up for the grand inspection, with a total disregard to the feelings of the inmates. My apartments smell of oil, and natives, and every other abomination. It is an extraordinary but undeniable fact, that comfort is incompatible with order. This is especially true in the case of your Debilitated; unless my books and pipes are where they ought to be—that is, scattered about the premises—where I can lay my hands on them, my condition is truly pitiable.

The whole staff have taken to electricity. It seeking distraction, I visit a friend; I find him immersed in Culley or Sabine, and, to my friendly greeting, he mutters some unintelligible nonsense about electrical measurements, and, after regarding me for a moment, with "lack-lustre eye," returns to his studies, leaving me to my own devices. These studies, I also find, are not conducive to good temper, and consider myself lucky when I receive a civil answer to any question not relating to the engrossing topic. The only amusement for the philosophic mind is to watch a few of these sucking electricians collected round that mysterious altar, the testing table, and to watch the expression of intense abstraction, with which one of them will attempt to follow the course of the current through all its intricacies; a second Newton, piercing, with eagle glance, the hidden mysteries of nature! Now, he sees it, and a smile of intense satisfaction lights up his intellectual features. His friend meanwhile has found the proper place in Culley, and the game commences. Taking the Constant is, I believe, the name given to this intellectual amusement. It is not dangerous, and, for the matter of that, might be introduced into families, but it would probably prove too expensive for most private fortunes; it is, therefore, preferable, when possible, to carry it on at the expense of Government. Several variations may be introduced by pulling out certain pegs, suddenly and without warning to your neighbours, which causes

*The repairing ship, in the Persian Gulf, belonging to H. M. Government, is named the *Amberwitch*, and is evidently familiarly alluded to as the "*Witch*."

considerable amusement, but is like to damage the apparatus; but this is of course a secondary consideration. The points in the game are the black coils and the yellow coils, but the rules appear to be somewhat intricate, for continual disputes occur on these matters. The rules might be simplified with advantage, and each player allowed to peg, yellow or black, as the case might be, just to suit his own game. I make this suggestion merely with a view of producing greater unanimity among the players, which is a desideratum, but, as it stands, it is a good fun to an onlooker. So ta ta!

AN ELECTRICAL WHALE.

Had I studied more, I might have been
The first upon the list;
But I spent my days at billiards,
And my evenings at whist.

When I heard I'd have to qualify
By the twentieth of November,
I worked as hard as I could work,
But little could remember.

And when the *Witch* came up the Gul
With the Electrician in her,
I felt myself shake in my boots,
As I'm a living sinner.

I was called into the Office;
The C. N. said to me,
"Come hither, now, my little man,
"We'll see what we shall see."

He took me gently by the hand,
And led me to the table:
Said, "There's the galvanometer;
"Let's see you test the cable."

Now, had the Superintendent
Been very ill or dead,
I said I could have tested
The cable in his stead.

But as the test book was not nigh,
And my head felt very queer,
I said, "Pray, Sir, excuse me,
"I'm not ready yet, I fear."

Then o'er his face a stern look came,
His brow grew black as night,
He said, "Young man, you trifle;
"Your conduct is not right!

"I came up to examine you:
To find out what you know;
I did not come to trifle, Sir;
And let me tell you so.

"I've a good mind, Sir, to spin you
For your horrid disrespect;
This is not the sort of answer
I had reason to expect."

Then softer thoughts came o'er him:
More pleasant was his glance;
He said to me, "I pity you,
I'll give you yet a chance.

"But if, when I come down the Gulf,
To test you are not able,
To find the insulation and
The conductor of the cable,

"Then, Sir, expect no mercy, for
Most certain 'tis that all
Your chances of promotion
Will be infinitely small."

So I've read up farads, ohms and volts,
But I find that all is vanity,
And the angle of torsion of my brain
Is, a function of insanity.

I've studied Kirchoff's laws, until
The end of all my thought
Is, that I'm full of currents
And the sum of them is o.

And if I pass or if I fail,
The end is very plain,
That if the strain continues long,
I must become insane!

ELECTROPHOBIST.

DANGER FROM OVERHEAD TELEGRAPH WIRES.

ON the afternoon of the 12th instant a singular accident happened in Farringdon-street. Charles Holmes, a cabman, was driving a hansom cab, and, when near the Viaduct, one of the Post-office telegragh wires passing over the road snapped, and fell about the horse's head and body. The animal took fright, and bolted for some distance down the road, until it got entangled in the wire in such a manner that it was thrown completely over. It was with great difficulty that it could be extricated, and it was then found to be so severely injured that it will probably have to be killed. The driver had a narrow escape.

A similar accident occurred about the same time in St. Bride-street. A telegraph wire broke, and a hansom cab driver was caught round the neck by the broken wire, but fortunately he was not injured.

Another accident of the same kind in Islington was unhappily fatal. A Brompton omnibus, after finishing its journey at about five minutes past two o'clock, pulled up as usual at the York Hotel, and one of the horsekeepers, named William Stevens, was driving it to the stables when a telegraph wire was blown away, and it fell round the poor fellow's neck, and nearly cut his head from his body. Mr. George Born, of Colebrooke-row, promptly attended, but death took place before his arrival. The body was conveyed to the stables prior to removal to the parish mortuary to await the coroner's inquest.

To Correspondent.

*** Duly authenticated contributions, theoretical and practical, on every subject identified with the interests to which "THE TELEGRAPHIC JOURNAL" is the organ, will always command attention. Anonymous correspondence will be wholly disregarded. Literary communications and books for review should be addressed to the EDITOR; business communications to the PUBLISHERS, 10, Paternoster Row, E.C.